

News

Space Environment Laboratory

The National Oceanic and Atmospheric Administration's (NOAA) Space Environment Laboratory (SEL), along with several other NOAA programs, is slated for a major budget reduction in FY 1985, a reduction which would have a serious impact upon the space environment services now provided by the laboratory.

SEL, jointly with the U.S. Air Force's Air Weather Service, operates the Space Environment Services Center (SESC) in Boulder, Colorado. SESC acquires, in near real-time, world-wide data on solar activity, on the terrestrial magnetic field, and on energetic particles at geostationary and polar orbiting satellite altitudes. Data are available to SESC from solar observatories operated by both the Air Force and a number of nongovernmental organizations, the NOAA geostationary and polar orbiting satellites, and a U.S.-Canadian magnetometer network.

Incoming digital data are processed in a dedicated computer system and displayed at the SESC forecast console where personnel issue forecasts and warnings of significant solar and geomagnetic activity to a wide variety of users. The data are available via computer-to-computer links, and forecasts and warnings are being distributed without delay using a commercial satellite broadcast system. Additionally, a synopsis of current geomagnetic and solar activity is broadcast on WWV-AM shortwave at 18 min past the hour, and is available via recorded phone message from SESC. Solar-geophysical data summaries are published weekly.

This real-time operation is supported by technique development efforts in SEL's Research Division. The division recently has implemented semi-automatic synoptic mapping of the global solar magnetic fields, as well as statistical maps of the total energy input into the polar region by energetic particle precipitation as measured by instruments aboard the NOAA/TIROS satellites.

The Systems Support Division is responsible, along with NOAA's satellite operations element (National Environmental Satellite, Data and Information Service), for the design and procurement of the space environment monitors on the two NOAA satellite systems, GOES and NOAA/TIROS. Recently, the division successfully demonstrated in the laboratory a prototype X ray imager designed to supply real-time X ray images of the sun. It is hoped such operational monitors can be flown on satellites by the 1990s.

In other developments at SEL, a new data base system, SELDADS II, has been procured and should be on-line by late 1985. Using a Data General MV10000 computer, the system will enhance SEL's capabilities to store and analyze the real-time data stream and will be able to run improved forecasting models.

The proposed budget reduction will impact upon SEL operations in a number of ways: Supporting technique development efforts for improving services will be lost; the present 24 hours per day forecast/warning schedule will be reduced to an 8 hour per day, 5 days per week operation; support for the satellite systems will be decreased, with the possible loss of the solar X ray imager system; the SELDADS II implementation will be delayed; and, the number of space environment products will be decreased, including a cutback in both the weekly "Preliminary Re-

port and Forecast of Solar Geophysical Data" publication, and the space environment summaries on the WWV broadcasts.

This news item was contributed by William J. Brennan, Public Affairs Officer, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Boulder, CO 80303.

Ocean Drilling Suggestions

The Ocean Drilling Program replaces the recently completed drilling phase of the Deep Sea Drilling Project (DSDP). A new and larger deep sea drilling vessel with expanded ca-

pabilities including a longer drill string, bare rock spud, enhanced logging, and the potential for riser drilling will replace the D/V *Glomar Challenger*. Drilling is scheduled to commence in January 1985, and planning is now underway for the tentative schedule shown below. The drill ship will then proceed to the Pacific Ocean and circumnavigate the earth at least twice during the 10-year program. Suggestions for drilling objectives, downhole experiments, etc., for all areas worldwide are now being solicited by JOIDES (Joint Oceanographic Institutions for Deep Earth Sampling).

Suggestions for use of the drill ship are reviewed by the JOIDES science advisory structure, which includes three thematic and five regional panels and four service panels. The advisory structure is supplemented as required by specialized working groups and task groups. Approved objectives will be integrated into the drilling program by the Planning Committee under the direction of the JOIDES Executive Committee.

JOIDES is also seeking persons with scientific or technical expertise to serve on advisory panels for approximately 2 year terms. Anyone wishing to be considered should send his or her vita to the JOIDES office.

JOIDES is an international organization made up of ten U.S. academic institutions and the science agencies of other member countries which presently include Canada, France, the Federal Republic of Germany, Japan, and the United Kingdom. Support for the Ocean Drilling Program is provided by the U.S. National Science Foundation, the Department of Energy, Mines and Resources of Canada, the Centre National pour l'Exploitation des Océans de France, the Bundesanstalt für Geowissenschaften und Rohstoffe of the Federal Republic of Germany, the Natural Environment Research Council of the United Kingdom, and the European Science Foundation representing Italy, The Netherlands, Norway, Sweden, and Switzerland. Participation in the Ocean Drilling Program and science advisory structure is open to anyone, and is not limited to representatives of JOIDES institutions or member countries. Drilling suggestions and proposals should be submitted to the JOIDES office, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149 (telephone: 305-361-4168).

This news item was submitted by Donald S. Marszalek, JOIDES Science Coordinator, Miami, Fla.

Tethered Satellite Opportunity

The National Aeronautics and Space Administration (NASA) and the Piano Spaziale Nazionale di Italy (PNS/CNR) are inviting researchers to participate in the first three flights of the Tethered Satellite System (TSS) on the space shuttle. The Tethered Satellite, a joint Italian/U.S. project, will deploy experiments in space at a distance of up to 100 km from the shuttle orbiter. Science instruments will remain tethered either upward or downward from the vehicle for approximately 16 hours at a

News (cont. from p. 345)

Solar Max: Three Hits, One Save...

In the end it was all smiles and congratulations, but the crew of the space shuttle *Challenger* and NASA engineers in Houston and at the Goddard Space Flight Center in Greenbelt, Md., were not forgetting how close the Solar Maximum (Solar Max) satellite repair mission had come to being the Solar Max destruction mission. In fact, if it had not been for a late night resuscitation effort by a team of engineers at Goddard and a particularly providential sunrise, the shuttle crew might never have gotten their hands back on the \$200 million orbiting solar observatory after a docking attempt on the mission's third day knocked it out of kilter. As it is, thanks to the astronauts' skilled repair work, the satellite is now ready for another 6 years or more of sun watching.

Solar Max had been stranded in space since 1980, the victim of blown fuses in its attitude control system that left four of its seven science instruments without accurate pointing capability. Shortly after the blow out, Goddard technicians had put the satellite in a slow "tumbling" spin to keep its solar panels pointing at the sun and the batteries charged up. In this tumbling pattern, turning at the rate of 1° per second, the first satellite designed to be reserved in orbit had awaited its rescuers for more than 3 years.

Challenger and its repair crew were launched on April 6, 1984. The trouble started two days later, when astronaut George Nelson tried to dock with Solar Max and steady it so that it could be picked up by the shuttle's long mechanical arm. Three times he tried to mate a cylindrical attachment device to a trunnion pin protruding from the satellite's midsection, but three times he bounced away without the device latching (the problem, it now appears, was with a small stud next to the pin that did not show up in engineering blueprints).

Seismic Cross Sections of the Upper Mantle

Surface wave tomography is being used to map the seismic velocity and anisotropy of the upper mantle on a global basis [Nabok et al., Anisotropy and shear-velocity heterogeneities in the upper mantle, *Geophys. Res. Lett.*, 11, 109-112, 1984].

The color figure shows cross sections of the upper 670 km of the mantle. (Note previous example published on the cover of *Eos*, April 17, 1984.) VSV is the velocity of vertically po-

Forum

Child Care at National Meetings

Is your participation in AGU meetings limited by the lack of child care facilities? Would you be willing to pay for such services? The AGU Education and Human Resources Committee surveyed a sample of members, and our findings were inconclusive. If your meeting attendance depends on the availability of daycare, please write a brief note to that effect, and send it to the committee at AGU Headquarters. If response to this request is sufficient, this committee will recommend that some action be taken.

Louise Levien
Member, AGU Education
and Human Resources Committee

Geophysical Weight Loss Diet

Having for numerous reasons acquired a three digit kilogram mass, the author is experienced at the painful struggles that the gourmand must suffer to reduce weight, particularly if he/she enjoys reasonably large amounts of good food. To the avant-garde geophysicist, utilizing the following approach could be pleasurable.

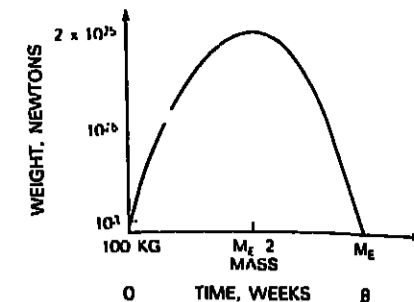
Up until this time, Solar Max had been turning like a very slow and steady top. Now, because of the docking jolts and Nelson's unsuccessful attempt to steady the satellite by grabbing onto one of its winglike solar panels, it was tumbling more rapidly around all three of its axes. The crew tried to grab the satellite with the shuttle's arm despite the un-

rewarding, and may even enable the accomplishment of what Ghengis Khan, Alexander the Great, Napoleon, and Hitler could not!

The basic approach is the full utilization of Newton's formula for the attraction of two massive bodies: $F = GM_1M_2/r^2$, where G is the gravitational constant; r , the distance between the two bodies; and M_1 and M_2 , the masses of the two bodies. Although one usually chooses M_1 to be the earth's mass M_E and M_2 to be the mass of a small object, this unnecessarily restricts the realm of phenomena. The less restrictive assumption is $M_1 + M_2 = M_E$.

Utilizing this latter equation has enabled the development of the Geophysical Weight Loss Diet. The figure is a plot of the expected weight changes. Do not fear the initial weight gain, for, as the curve shows, a final weight loss is guaranteed!

The Diet: Week 1, Consume herds of cattle, devastate crop fields.
Week 2, Pillage villages, farms, and lay waste to the countryside.
Week 3, Develop a taste for small mountain ranges, gorge your thirst on great lakes.
Week 4, Delight on crustal dining, sample the refreshing taste of a small ocean.
Week 5, Enjoy more of the pie, taste the mantle below the crust, nibble on the core for dessert.
Week 6, Work your way through to the other



side; no need to worry about iron pills. Week 7, Watch those pounds disappear. Week 8, Finally enjoy the culture and food of the antiquities.

As with many diets, there are some side effects. The worst appears that there is nothing left to eat at the end, unless one becomes an astronomical gastronomer!

Acknowledgement: The benefits of this approach were discussed with Kwang Chan, Dick Goldberg, Hans Mayr, and Nathan Miller et al. during a Chinese New Year's festivity.

Kenneth Schatten
Solar Radiation Officer
NASA Goddard Space Flight Center
Greenbelt, MD 20771

predictable tumbling, and came "close, but no cigar," according to commander Robert Crippen, before getting word that technicians at Goddard (Solar Max's command center) believed they could stop the satellite's rotation from the ground.

What followed was a day-long race to get the spacecraft under control before it ran out

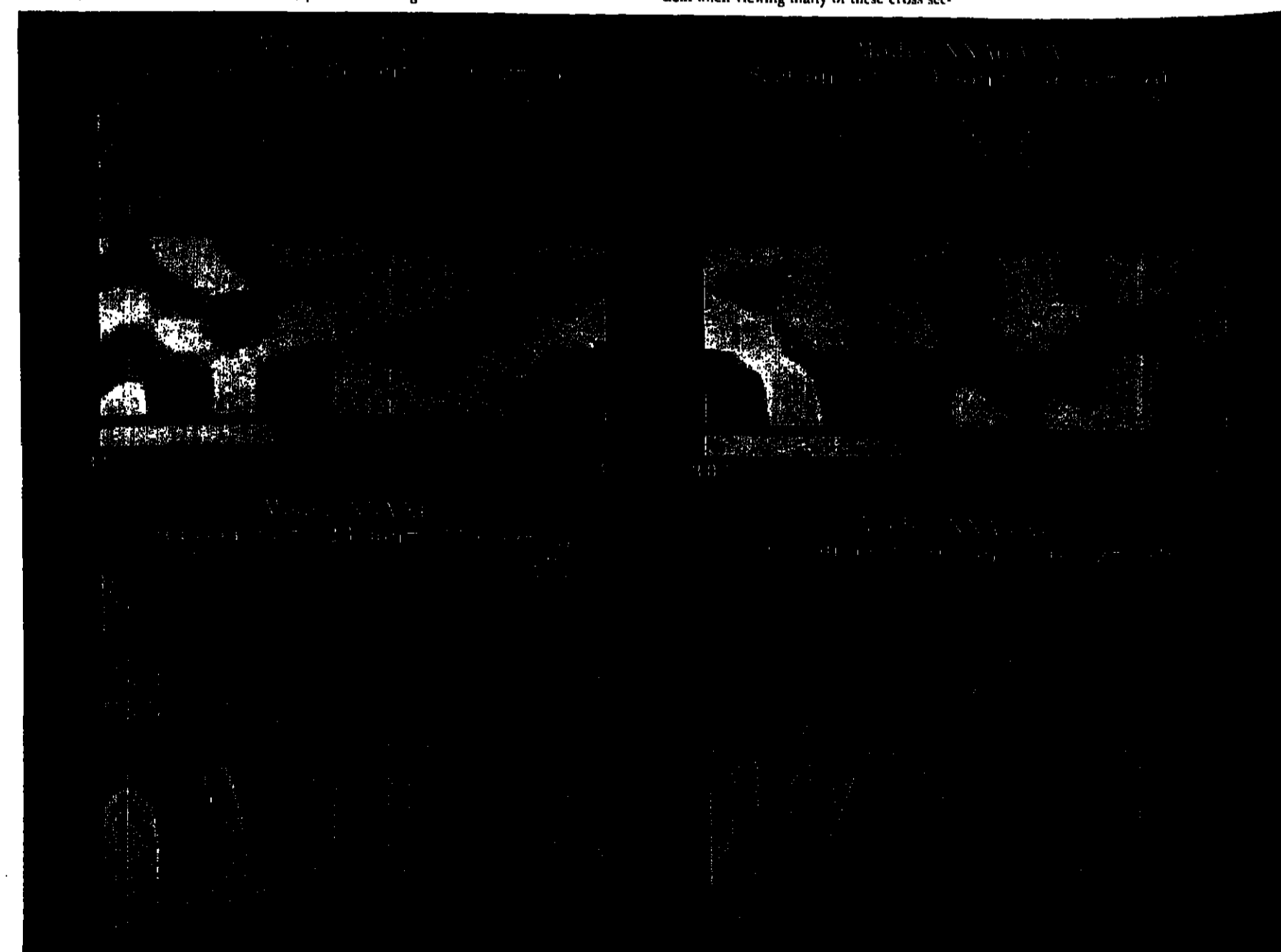
of power, because now that its panels were no longer pointing at the sun, Solar Max's on-board batteries were draining without recharging. After shutting off all the spacecraft systems they could stop the satellite's rotation from the ground.

The team activated magnetic torquer bars in the spacecraft that act as a kind of lever against

the mid-Atlantic ridge appears to be shallow on these cross sections but can be traced to greater depth in other sections. This suggests that there is large lateral transport of material between source and ridge.

Tomographic research at Caltech is supported by National Science Foundation grants EAR-8115236 and EAR-8317823. I thank Robert Clayton, Bradford Hager, and Adam Dziewonski for assistance in making the illustrations.

This news item and photo was contributed by Don L. Anderson, Seismological Laboratory, California Institute of Technology, Pasadena, CA 91125.



the earth's magnetic field, a crude form of backup attitude control. At first the engineers thought this was working. Soon, though, it became apparent that the satellite's gyroscopes were being overloaded by the high rates of motion and were not giving the proper information about the spacecraft's position to the torquer bars.

Once the Goddard team realized this problem, they devised a new plan. By telemetry command, they dumped the satellite's on-board computer and sent up a new attitude control program called "B-Dot" that used magnetometer rather than gyroscope data to sense the spacecraft's position. This trading of programs took nearly 3 hours to complete, but it worked; the torquer bars almost immediately began to steady the satellite.

Now there was a new worry. B-Dot was very good at absorbing momentum, but it didn't allow for any attitude control from the ground. The Goddard team had no way to get the solar panels pointed back at the sun. Meanwhile, the batteries were losing energy with each nighttime pass. Finally, drained to about 225 watts of power, Solar Max was not expected to live much longer than one more period of darkness. Ground controllers turned off the satellite's on-board radio transmitter just before it entered eclipse again in a fast-gasp attempt to save another 25 watts, and then they waited.

Miraculously, when the spacecraft came into sunlight again, its solar panels were facing the sun enough to begin recharging the batteries. With each succeeding orbital pass, the sun angle got a little better and the batteries a little stronger to the point where ground technicians were able to reload the original computer program, reestablish attitude control, and point the panels toward full sunlight. By morning the power was up to 100%, Solar Max was again turning neatly at the rate of one half a degree per second (slow enough for the shuttle arm to grapple), and the Goddard engineers were able to relax for the first time in what had been a very long 24 hours.

EOS

Transactions, American Geophysical Union

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Cover. The AGU and its logo are now a part of the Washington skyline and are prominent features on Florida Avenue, N.W., and nearby Connecticut Avenue. Those of you who have been contributing to the future of AGU can now see some tangible evidence of these investments. Of course, the real action is on the inside. If you are in Washington, D.C., and in the neighborhood of the building, come inside, go to the eighth floor, and see the plaque bearing the names of the major contributors to the AGU GIFT Fund. If your name is not on this list, the GIFT Fund Steering Committee would be very pleased to add it. The plaque is a proud symbol of the esteem AGU elicits from its members as is the Headquarters building in which it resides. (Photos by Cynthia Bravo. AGU logo designed by Dae Sung Kim.)

...And 6 More Years of Science

After these heroics, the rest of the repair mission went more or less according to the (amended) script. The crew was able to retrieve the satellite, fix its attitude control system and coronagraph/polarimeter instrument as planned, then redeploy Solar Max in its 500-km-high orbit on April 12.

Barely was the satellite back in service again when it got the chance to observe the eruption of a major solar flare, through what Solar Max project scientist Bruce Woodgate calls "a combination of anticipation and rapid re-pointing." The satellite had been near the middle of a 30-day engineering checkout period when, on April 23, the onboard hard X-ray burst spectrometer began detecting flare bursts in a particularly active region on the sun. Project scientists then requested Goddard technicians to move the satellite and point its narrow field instruments at the active region, with the result that half an hour later the satellite was perfectly positioned to record the largest flare of the current solar cycle occurring on the sun. "We got lucky there," says Woodgate. So interesting were the data returning from this flare region that Solar Max was scheduled to remain in its "science mode" for about 2 weeks before picking up again with the engineering healthchecks.

Once it returns to full-time science, the satellite is expected to return data until it reenters the atmosphere, probably sometime in 1990 or 1991. Although it was launched primarily to study solar flares, in its second incarnation Solar Max will divide its observing time more evenly between flares and other solar phenomena. Prominences—long streamers of mass exploding outward from the sun's limb (edge)—will be studied in a viewing program coordinated with ground observatories in Hawaii, California, and France. The satellite will also continue to monitor the solar constant, or total energy output that reaches earth (which it saw to be declining in 1980), and will take daily or near-daily images of the corona so that scientists can have a record of its changing shape at different periods in the solar cycle.

One of the more intriguing problems to be tackled by Solar Max involves the high-energy gamma ray emissions from solar flares seen by the gamma ray spectrometer in 1980. The gamma ray results showed flares with much higher energies and faster "rise times" than had been previously expected. In fact, no current theory of particle acceleration can explain them. Before Solar Max, only lower energy gamma rays with rise times of minutes (as opposed to less than 3 seconds) had been seen streaming from the sun. "We need to work on theories to explain how this energy rise can happen," says Woodgate.

A windfall of Solar Max's revival after 3 years of dormancy is that scientists will now be able to interact more closely with the satellite in real time, thanks to NASA's Tracking and Data Relay Satellite System (TDRSS). The satellite link is expected to allow observers on the ground to change viewing modes or re-point Solar Max instruments in near-immediate response to events happening on the sun, something they could not do in 1980 when the TDRSS wasn't in place. "With a person in the loop," says Woodgate, "we'll be able to do more pattern recognition" of features and rapidly occurring events on the sun. The sun is not the only target in Solar Max's viewing plan. When Halley's comet swings around the sun in February 1986, several instruments, including the coronagraph/polarimeter repaired by the *Challenger* crew, will return data and visual images of the com-

et and its attendant tail. Solar Max will observe Halley from early January to late March, both before and after its closest sun approach, at a time when ground observation will be difficult if not impossible. A fleet of

Halley-bound spacecraft will take much closer looks in March, but for a period of about 2 months in early 1986, says Woodgate, "we will be the only observatory that will be able to observe the comet."—TR

In Congress

Legislative Update

ARCTIC RESEARCH AND POLICY ACT, H.R. 2292 (Young, R-Alaska) and S. 375 (Murkowski, R-Alaska), would provide comprehensive national policy dealing with national needs and objectives in Arctic and would provide a centralized system for collection and retrieval of scientific data, establish priorities, and provide financial support for basic and applied scientific research.	Senate Passed June 27, 1983	House Passed April 24, 1984
EARTHQUAKE HAZARDS REDUCTION ACT, H.R. 2465 (Walgren, D-Pa.) and S. 820 (Gorton, R-Wash.), now public law P.L. 98-241, authorizes \$87 million for fiscal 1984 and a 5% increase for inflation for fiscal 1985. S. 820 passed the Senate April 7, 1983, and passed the House Feb. 1, 1984. Signed into law on March 22, 1984.	P.L. 98-241	P.L. 98-241
EXCLUSIVE ECONOMIC ZONE IMPLEMENTATION ACT, H.R. 2061 (Breaux, D-La.) and S. 750 (Stevens, R-Alaska), would implement 200-mile EEZ adjacent to the U.S. territorial sea. Would also set forth U.S. policy on development and use of the natural resources and ocean floor. H.R. 2061 referred to House committees on Foreign Affairs, Interior and Insular Affairs, Merchant Marine and Fisheries, and Ways and Means. S. 750 referred to Senate Committee on Commerce, Science, and Transportation.	Hearings to be scheduled	Hearings to be scheduled
EXPORT ADMINISTRATION ACT AMENDMENTS, H.R. 3531 (Bonker, D-Wash.) and S. 979 (Heinz, R-Pa.), defines restrictions on the export of scientific and technical information. House passed its bill Oct. 27, 1983, and sent it to the Senate. S. 979 passed the Senate March 1, 1984, and passed the House March 8, 1984. A conference to iron out the differences was held April 12, 1984.	In conference	In conference
LAND REMOTE SENSING COMMERCIALIZATION ACT OF 1984, H.R. 5155 (formerly H.R. 4836) (Fugate, D-Fla.) and S. 2292 (Gorton, R-Wash.), aims to establish a system to promote the use of land remote-sensing satellite data. Asserts that the private sector is best suited to develop land remote-sensing data markets and that cooperation between the federal government and the private sector should be initiated now to assure continuity of data and U.S. leadership in land remote sensing. A fully commercialized system should be phased in gradually, according to the bill.	Hearings May 8, 1984	Passed April 9, 1984
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION ORGANIC ACT, H.R. 3381 (Forsythe, R-N.J.), would establish NOAA as an independent agency and as the agency primarily responsible for providing oceanic, coastal, and atmospheric services and supporting research (<i>Eos</i> , Sept. 6, 1983, p. 537). Would also establish procedures to avoid duplication of effort in these fields among government agencies. Referred to two subcommittees of House Merchant Marine and Fisheries Committee, and one of House Committee on Science and Technology. Several other bills that would establish a Department of Trade also call for making NOAA a separate agency. Merchant Marine Committee reported the bill out of committee April 10, 1984.	No companion bill	Awaiting further committee action
NATIONAL OCEANS POLICY COMMISSION ACT OF 1983, H.R. 5853 (W. Jones, D-N.C.) and S. 1238 (Hollings, D-S.C.), would establish a 15-member commission that would develop recommendations for Congress and the President on a comprehensive national oceans policy. S. 1238 referred to Senate Commerce, Science, and Transportation Committee.	Awaiting committee action	Passed Oct. 31, 1983
PEER REVIEW REAFFIRMATION, H.Con. Res. 257 (Sensenbrenner, R-Wisc.), would reaffirm "the commitment of the Congress to award federal funds for scientific research projects and facilities solely on the basis of scientific merit as determined by a peer review process." Follows attempts by several universities to bypass peer review (<i>Eos</i> , January 3, 1984, p. 1). Referred to House Science and Technology Committee. (A concurrent resolution is used to express principles and policy.)	No companion resolution	Awaiting committee action
SCIENCE AND MATHEMATICS EDUCATION, H.R. 1510 (Perkins, D-Ky.) and S. 1285 (Hatch, R-Utah). H.R. 1510 allocated \$425 million for mathematics and science education in fiscal 1984 (<i>Eos</i> , March 22, 1983, p. 114). Senate bill, which also would authorize \$425 million, was reported out of the Senate Labor and Human Resources Committee May 16, 1983.	To be scheduled on Senate calendar	Passed March 2, 1983
SEVERE STORMS ADVISORY COMMITTEE ACT, H.R. 5207 (Hammerhead, R-Ark.), aims to assure that forecasting of severe storms within government agencies is coordinated for maximum benefit. Would establish a committee of no more than 12 members that would recommend new programs, assess current forecasting programs, and make recommendations for incorporating new technology developments into the operational forecasting system. Referred to a subcommittee of the House Science and Technology Committee.	No companion bill	Awaiting committee action
WATER RESOURCES RESEARCH ACT OF 1984, S. 684 (Abdnor, R-S.Dak.), now public law P.L. 98-242, provides for the establishment of one water resources research and technology institute in each state and territory to "plan, conduct, or otherwise arrange for competent research with respect to water resources . . . promote the dissemination and application of the results of these efforts; and provide for the training of scientists and engineers through such research, investigations, and experiments." Passed the Senate May 28, 1983, and passed the House Oct. 31, 1983. President Reagan vetoed the bill Feb. 21, 1984. The Senate overrode the veto (88 to 12) on March 21, 1984, and the House overrode the veto (309 to 81) March 1984.	Veto overridden March 21, 1984	Veto overridden March 22, 1984
YEAR OF WATER, S.J. Res. 202 (Armstrong, R-Ohio), would designate 1984 as the Year of Water. Aims to increase awareness and dedication to the interests of worldwide water resources (<i>Eos</i> , March 20, 1984, p. 105). Referred to House Committee on Post Office and Civil Service.	Passed Feb. 27, 1984	No companion resolution

For additional information, contact the sponsoring Member of Congress or committee indicated. All congressional and committee offices may be reached by telephoning 202-224-3121. For guidelines on writing to a member of Congress, refer to *AGU's Guide to Legislative Information and Contacts* (*Eos*, April 17, 1984, p. 159). The last Legislative Update was published in the January 24 *Eos*.—BTR

Books

Ground Water Monitoring Technology: Procedures, Equipment, and Applications

Robert D. Morrison, Timco Mfg., Inc., Prairie du Sac, Wis., xv + 111 pp., 1983, \$33.

Reviewed by Kenneth R. Bradbury

Over the past few years, increased interest in groundwater monitoring has resulted in numerous new articles about, equipment for, and approaches to the field measurement of physical and chemical groundwater parameters. *Ground Water Monitoring Technology* is a useful book that attempts to make sense of this recent information by organizing it into sections on monitoring the vadose zone (part 1), monitoring the zone of saturation (part 2), and groundwater sampling equipment (part 3). According to the preface, "A degree of discrimination was exercised in selecting technologies which were directly applicable for field use." The book emphasizes "field proven methods which have been documented" at the expense of other promising but unproven field techniques, and it omits laboratory methods except where required for instrument calibration. Morrison is aware of the rapidly changing nature of current groundwater field techniques and has written the book so that it "will be useful even after a particular instrument becomes obsolete."

Ground Water Monitoring Technology is not a "cookbook" of step-by-step instructions for field investigations, nor is it a collection of case studies. Instead, it is a compilation of various field methods, each carefully documented by references to the literature, with the emphasis on equipment rather than technique. In fact, the strength of this book is the collection of 481 references, which refer to monographs and periodicals in a number of associated scientific fields, primarily including, but not limited to, hydrogeology, hydrology, geophysics, soil science, engineering, and meteorology. These references alone are probably worth the price of the book. For each technique discussed, the author briefly describes the theory and equipment involved. The interested reader can then go to the references cited to obtain more detailed information about a particular method or item of equipment.

Part I of the book, dealing with monitoring in the vadose zone (35 pages; 380 references) is excellent in scope and detail, and many readers may want to purchase the book solely for this chapter. Sections on soil moisture po-

tential, soil moisture content, soil salinity, temperature, and soil pore water sampling provide a good review of "traditional" techniques such as tensiometry, moisture blocks, electrical conductivity probes, and vacuum pressure lysimeters, while introducing newer techniques such as Nuclear Magnetic Resonance and inductive electromagnetism, which may be unfamiliar to many readers. Professionals involved in contaminant monitoring will be particularly interested in the section on soil pore water sampling, which discusses how various lysimeter materials (ceramics, nylon, fritted glass, Teflon) can affect the quality of water samples.

Part 2 addresses monitoring in the saturated zone (14 pages; 64 references), and includes sections on drainage systems, trench and caisson lysimeters, monitoring wells, well points, well clusters, multilevel samplers, hybrid well systems (a combination of saturated and unsaturated zone monitoring), and piezometers. The strength of part 2 is its emphasis on new monitoring techniques, such as various multilevel samplers. The chapter is very adequate in its coverage of hydraulic head measurements, devoting only two pages and eight references to piezometers and containing essentially no discussion of the precision and accuracy of various water level measurement techniques. In view of the extensive discussion of head measurement in the unsaturated zone and the importance of hydraulic head as the fundamental measurement in hydrogeology, these are curious omissions. In addition, there is no discussion of the applications of the various analog and digital water level recorders available today and which are often integral components of a groundwater monitoring program.

The third part of the book contains a brief but adequate (10 pages; 37 references) discussion of water sampling equipment, including bailers, various suction and submersible pumps, and packer pumps. Once again there is an emphasis on how various sampler materials (PVC, stainless steel, Teflon, etc.) can affect water sampling results. The chapter could have been improved by including one or more tables summarizing the adequacy of materials and techniques for sampling various organic and inorganic chemical constituents.

Consultants and researchers involved in groundwater contamination studies will find this book valuable. Most of the equipment described is best suited to relatively shallow investigations (on the order of a few hundred feet or less) and there is a strong emphasis on contaminant studies. Investigators interested in monitoring deeper groundwater systems or in water quantity studies may find the book less useful. The book is clearly written and well illustrated with legible drawings and

Important Professional Reading...

Ninth International Congress of Carboniferous Stratigraphy and Geology

Volume 1: Official Reports

Edited by MACKENZIE GORDON, Jr. This was the first Congress to be held in the United States and it attracted more than 900 geologists from 29 countries. Highlights of this volume include a special lecture on the Carboniferous of China, a concise summary of the tectonic evolution of the Iberian massif, a short history of the founding of the Carboniferous System, an incisive look at world energy prospects for the next two decades, an outline of the geology of the Spanish Carboniferous coalfields, and a novel treatment of detail paleobotanical comparisons between west European coal basins and the Donetz basin. \$25.00

High Sulphur Coal Exports

An International Analysis

Edited by MICHAEL M. CROW. Preface by SENATOR CHARLES PERCY and REPRESENTATIVE PAUL SIMON. The papers in this book were generated by the proceedings of the United States Senate Field Hearing and High Sulphur Coal Export Conference held in June of 1981. \$30.00

Blast Vibration Analysis

By G. A. BOLLINGER. This volume synthesizes theory and literature from seismological, geophysical, and engineering fields pertinent to blast vibrations induced by mining, quarrying, and engineering operations. \$6.95 paper

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photographs. A glossary provides definitions of most technical terms used in the book, although a few, such as "cartesian monostat," and, surprisingly, "monitoring," are omitted. Although the publishing company (Timco) is in the business of selling groundwater monitoring equipment this book thankfully does

not promote Timco products over the products of other firms.

Kenneth R. Bradbury is with the Wisconsin Geological and Natural History Survey, Madison, WI 53706.

If available, apply to either Dr. James M. Brooks or Dr. Malhotra C. Kinnikutt II, Department of Oceanography, Texas A&M University, College Station, Texas 77843.

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Satellite Scientist

The Planetary Sciences Group of the EG&G Washington Analytical Services Center, Inc. has an immediate opening for a qualified Space Scientist whose expertise includes: geogravity modeling and recovery, surface gravimetry and the upward continuation of surface potential models, and the effect of smoothing algorithms of local data sets on potential coefficient determination. The successful candidate will assist the gravity field investigations underway in preparation for TOPEX. This position requires a Ph.D. degree in Geodesy with three years of professional experience. Salary to \$30K. If you are interested, please contact S. Kiosko, at 301-779-2800. EG&G is an equal opportunity employer.

EG&G Washington Analytical Services Center, Inc.
6801 Kenilworth Avenue
Riverdale, Maryland 20737

EG&G

Postdoctoral Position in Upper Atmospheric Physics. A postdoctoral position is available in the Space Physics Research Laboratory at the University of Michigan for a qualified candidate with a Ph.D. degree and experience in Upper Atmospheric Physics. The position involves the analysis of data obtained from two instruments flown on the NASA Dynamics Explorer-2 satellite. The extensive satellite data base provides detailed information of the Dynamics, Thermodynamics and Compositional Structure of the Neutral Upper Atmosphere. The appointment will be for one year (renewable) and is to start in October, 1984. The applicant should identify and describe areas of his or her expertise that can support theoretical investigations in Upper Atmospheric Physics. A resume and the names of three persons knowledgeable of the applicant's experience should be forwarded to:

Dr. T.L. Killeen
Space Physics Research Lab.
Department of Atmospheric and Oceanic Sciences
The University of Michigan
2455 Hayward
Ann Arbor, MI 48100-2143
The University of Michigan is a non-discriminatory/affirmative action employer.

Faculty Position in Planetary Science. A junior faculty position in the Department of Earth, Atmospheric, and Planetary Sciences at MIT is available for a recent Ph.D. graduate in the field of planetary dynamics. Applicants should have a solid background in classical celestial mechanics, as well as modern computer-assisted numerical theory and should have demonstrated proficiency in attacking problems involving spin-orbit coupling and multi-body orbital evolution. Individual must have a strong interest in teaching graduate and undergraduate students.

Applicants should submit curriculum vitae, a brief statement of research interests, and names of three references to:

Dr. William F. Brace, Chairman
Earth, Atmospheric, and Planetary Sciences
54-918, M.I.T.
Cambridge, MA 02139.

Closing date: June 15, 1984.
MIT is an affirmative action/equal opportunity employer.

Massachusetts Institute of Technology, Haystack Observatory/Atmospheric Scientist. The Haystack Observatory is accepting applications for an anticipated Atmospheric Scientist position for one year period, equivalent to a post-doctoral appointment, to work in the field of upper atmospheric physics with the Millstone Hill Atmospheric Sciences group. The scientist will participate in the analysis of data from multi-technique experimental campaigns performed under the Global Thermospheric Mapping Study program being coordinated from Millstone Hill. The applicant should have a M.S. or Ph.D. in a field of upper atmospheric science and familiarity with computers, magnetic tape formats, computer graphics and display techniques. New Ph.D. preferred. Please write, enclosing resume, to:

J.T. Karaki
Assistant to the Director
Haystack Observatory
Westford, MA 01886

MIT is an equal opportunity/affirmative action employer.

Faculty Position in Geophysics. Texas A&M University has a tenure track assistant professor position open starting in the fall of 1984. This is a new position and we will consider applications from outstanding candidates in any area of solid earth geophysics. Preference, however, will be given to candidates with backgrounds and interests in exploration geophysics, particularly in electrical and magnetic methods. The Department of Geophysics at Texas A&M currently has 17 faculty, 65 graduate students and 100 undergraduate students. The current faculty research emphasis is in the following areas: exploration geophysics, engineering geophysics, tectonophysics, internal earth structure, geodynamics, and general geophysics. Geophysicists maintain close contacts with the Ocean Drilling Program and intend to participate actively in the Continental Scientific Drilling Program. The Department has a VAX 11/780 computer and has just moved into a new building.

Applicants should send their resume and the names of three references by June 1, 1984 to E. Hoskins, Department of Geophysics, Texas A&M University, College Station, TX 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

Geoscience Data Manager and Staff/Texas A&M University. Geoscience Data Manager and Staff, Ocean Drilling Program, Texas A&M University, assemble and monitor all of the electronic data and paper data collections produced on the drilling vessel and during subsequent shore studies, including quality control, preparation of data syntheses and documentation, response to instrument design and support of research activities. Geoscience bachelors or masters degree required. Experience in data base operations desirable. Total of three positions to be filled. Send a letter of application, resume, and several of your references, and other relevant information to: Dr. Russell Merrill, Curator and Manager of Science Services.

Ocean Drilling Program
P.O. Drawer GK
College Station, Texas 77843
Application deadline is June 1, 1984.

Utah State University/Postdoctoral Position. One postdoctoral position is available in the Department of Physics and the Center for Atmospheric and Space Sciences at Utah State University. Candidates should have a Ph.D. degree in theoretical and/or experimental astrophysics/physics. Experience in the following areas will be advantageous: expanding the development of comprehensive models of the ionosphere and dynamics of the thermosphere/spheromagneticosphere. Opportunities exist to participate in atmospheric balloon, space shuttle, and satellite flights, in the design and fabrication of experimental instruments, and in data analysis and theoretical modeling. A comprehensive database of terrestrial emissions covering the extreme ultraviolet to the near infrared, and extending from the surface of the earth to the thermosphere, was recently acquired on Spacecraft 1, providing significant data on the development of comprehensive models of the ionosphere and dynamics of the thermosphere/spheromagneticosphere. It is planned to extend the modeling work to the stratosphere and mesosphere in support of balloon measurements of key radicals.

Interested persons should submit a resume and the names of three individuals who can be contacted for reference purposes.

D.G. Torr
Department of Physics
Utah State University, UMC 41
Logan, Utah 84302
before May 25, 1984. Salary will be commensurate with experience.
The Utah State University is located in scenic northern Utah, and is an affirmative action/equal opportunity employer.

PROJECT MANAGER MATERIALS SCIENCES

(Columbus, Ohio Location)

The Project Management Division of Battelle Memorial Institute has an immediate opening in its Office of Nuclear Waste Isolation (ONWI) for a person to assist in all aspects of management of subcontractors in geologic application of materials sciences; review technical quality of the work and coordinate programmatic application of the results; develop data base and models from results of subcontractors; perform design analyses of materials behavior, waste form behavior, and nuclear-field interactions for waste packages, repository seals, and other repository items in their applications to deep geologic disposal of high-level nuclear waste.

Requirements include superior written and oral communication skills and an MS/Ph.D. in a materials science specialty with a background in the earth sciences or a strong asset. Demonstrated leadership qualities and experience in nuclear waste disposal and management of large projects/R&D efforts desirable.

We offer a comprehensive benefits package and an excellent salary, commensurate with your background. Send your resume, in confidence to:

Rosalind Drum
Battelle
Project Management Division
505 King Avenue
Columbus, Ohio 43201



AN EQUAL OPPORTUNITY EMPLOYER

Postdoctoral Fellow in Igneous Petrology. Available August 15, 1984. Areas of research include mineralogy/petrology/geochemistry of kimberlites and basalts. A working knowledge of the electron microprobe is required. Please send resume, short summary of research goals and the names of three persons who may be contacted for recommendation to: L.A. Taylor

University of Tennessee
Department of Geological Sciences
Knoxville, TN 37996
We'll be at the AGU Meeting in Cincinnati. Contact L.A. Taylor at T-1344.

Assistant Curator/Texas A&M University. Assistant Curator, Ocean Drilling Program, Texas A&M University, to oversee operations of ODP core repositories, including cataloging and maintenance of collections, supervision of personnel, processing of sample requests according to JOIDES/ODP sampling policy, and participation in drilling cruises. Masters or PhD in sedimentology, paleontology, or related area preferred. Send letter of application, resume and names of four references to: Dr. Russell Merrill, Curator and Manager of Science Services, Ocean Drilling Program, P.O. Drawer GK, College Station, Texas 77843. Application Deadline is June 1, 1984.

Laboratory for Atmospheric and Space Physics. The Laboratory for Atmospheric and Space Physics of the University of Colorado invites applications for the position of Research Associate. We anticipate openings in active space research programs in the disciplines of planetary atmospheric science, earth's atmosphere and ionosphere, solar physics and astrophysics. LASP facilities include the operations control and data analysis center for the Solar Mesosphere Explorer; an IUE Regional Data Center; rocket experiments; response to instrument design and fabrication facility; LASP also has experiments on Pioneer Venus, Voyager, Galileo and the Upper Atmosphere Research Satellite. In addition, sounding rocket experiments will be conducted in 1984 and several of these will evolve to shuttle SPARTAN payloads over the next few years. LASP engineering facilities allow the in-house design, fabrication and calibration of state-of-the-art hardware and scientific data analysis and theoretical studies. The Laboratory is an Institute of the University's graduate school and has close ties with the Departments of Astrophysical, Planetary and Atmospheric Sciences and of Aerospace Engineering. A doctorate in a relevant subject is required; salary in accord with experience.

Send letters of application with an updated resume and the names of two references to: A.L.F. Stewart
University of Colorado

Campus Box 8-10
Boulder, CO 80501
Applications are being accepted on a continuing basis.

The University of Colorado is an affirmative action/equal opportunity employer.

Research Associate/Research Technician. The University of Maine at Orono (UMO) has an opening for a research associate/research technician who would work in a small geophysical group. We seek an individual who can use and maintain modern digital electronic equipment for example, microcomputer, 40 interface for microcomputer channel analyzers, 40 interface for microcomputer, digital plotter and digitizing tablets. Familiarity with BASIC and FORTRAN will be needed, and some geophysical field work may be required as part of the duties of the associate. Current funding permits an appointment for at least 12 months, subject to arrival of anticipated funding. The appointment period could be extended to two years, or longer. Call Edward R. Decker at 207-581-2158 or 207-581-2159 about the position. Otherwise, send inquiries, a vita and a list of at least three references to Edward R. Decker, Department of Geological Sciences, 110 Boardman Hall, University of Maine at Orono, Orono, ME 04469.

The University of Maine is an equal opportunity affirmative action employer.

Ocean Scientist/Engineer

For highly influential role in a top energy company.

ARCO Oil and Gas Company, Dallas, is a division of Atlantic Richfield Company that has very considerable offshore interests. Your responsibilities—assisting development of design criteria—will influence: Economic analyses of potential lease areas. Platform design. Rig selection. And offshore operations.

Your scope will include...

- Developing and applying meteorologic and oceanographic technology to characterize various offshore areas.
- Evaluating existing data, and sponsoring/supervising studies to acquire new data.
- Doing field work; representing ARCO on joint industry projects.

Credentials sought: MS/PhD in meteorology, physical oceanography or ocean engineering, 3 or more years directly in the oil and gas industry or as an industry consultant. Computer modeling experience preferred. Must be skilled communicator who can work independently and lead work of contractors.

Salary and benefits are competitive. For prompt, confidential consideration, please send resume with salary history to: Mr. David M. Forsythe, ARCO Oil and Gas Company, P.O. Box 2819, Dallas, Texas 75221.

ARCO Oil and Gas Company

Division of Atlantic Richfield Company

An equal opportunity employer



KING SAUD UNIVERSITY RIYADH, SAUDI ARABIA

SEISMOLOGY

AND SOLID EARTH GEOPHYSICS:

King Saud University and its planned National Geophysical Observatory invite applications for the following positions:

- 1) *Seismologist, PhD with experience in a digital seismograph network and earthquake data analysis.*
- 2) *Solid earth geophysicist, PhD with experience in seismotectonics.*
- 3) *Geophysicist, PhD with experience in synthetic and theoretical seismology.*
- 4) *Computer scientist, PhD with experience in a digital seismograph network.*
- 5) *PhD/MS in engineering/geophysics with experience in digital data transmission and telemetry.*

Duties will include the routine operation of the National Geophysical Observatory, research in the fields of seismology/solid earth geophysics and teaching. Salary and position will be determined by the applicant's qualification and experience.

Applications accompanied by copies of Academic and Experience certificates should be mailed within one month to:

The Dean,
College of Science,
P.O. Box 2455
King Saud University,
Riyadh, Saudi Arabia

Classified

RATES PER LINE

Positions Available, Services, Supplies, Courses, and Announcements: first insertion \$5.00, additional insertions \$4.25.
Positions Wanted: first insertion \$2.00, additional insertions \$1.50.
Student Opportunities: first insertion free, additional insertions \$2.00.

There are no discounts or commissions on classified ads. Any type of style that is not publisher's choice is charged at general advertising rates. For a published weekly on Tuesday. Ads must be received in writing by Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box 5, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, DC 20009.

For more information, call 202-462-6903 or toll-free 800-424-8488.

POSITIONS AVAILABLE

The Colorado School of Mines. The Department of Geophysics of the Colorado School of Mines expects to have an opening for the academic year 1984-1985 for a candidate with experience in coal geophysics, earthquake seismology or seismic risk. The Department emphasizes geophysical exploration and applied geophysics, and preference will be given to the candidate who can bring that emphasis to his particular field of expertise. An extensive suite of field equipment and computers is available to support research projects. The Department operates a seismic observatory that is part of the worldwide network. We expect that the appointment will be made in the Assistant Professor level; however, an accomplished scientist with a background in one of the areas of interest could be considered at a higher level. Please send applications, resumes and/or inquiries to: Philip R. Roubig, Professor and Head, Department of Geophysics, Colorado School of Mines, Golden, Colorado 80401.

The Colorado School of Mines is an affirmative action/equal opportunity employer.

Postdoctoral Fellow in Atmospheric Science. A position will be available beginning October 1, 1984, at the Harvard-Smithsonian Center for Astrophysics for theoretical analysis of the shuttle glow and studies of upper atmosphere physics and chemistry. A Ph.D. which involved research in aeronomy, is required. Send applications and names of three references to: A. Dalgaro, Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138.

Metamorphic Petrology/University of New Brunswick. The Department of Geology invites applications for a tenure track faculty position in metamorphic petrology at the assistant professor level. We are seeking a field-oriented petrologist with microprobe experience to complement our existing programs in petrology and tectonics. The successful candidate is expected to participate in all aspects of teaching and advising at the graduate and undergraduate level as well as maintaining an active research program.

The department houses a variety of facilities for petrologic research including automated X-ray diffractometer and fluorescence unit and an automated atomic absorption spectrophotometer. Other analytical services are available on campus including transmission and scanning electron microscopy units.

The position is available starting September, 1984 pending final budgetary approval. Ph.D. required. Rank and salary will be commensurate with experience and qualifications. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Letters of application including a statement of current and future research, as well as a curriculum vitae, bibliography and three letters of reference should be sent to: Dr. P.F. Williams, Chairman, Department of Geology, University of New Brunswick, Fredericton, N.B., E3B 5A3, Canada.

Technical Specialist in Seismology. The Geophysics Group of the Department of Earth and Space Sciences, State University of New York at Stony Brook, is seeking candidates for the position of Technical Specialist in Seismology to operate and maintain the Stony Brook seismic network. Must have experience in seismic network operation and microearthquake analysis, also exposure to inverse theory and digital data analysis and familiarity with northeastern U.S. seismological studies. M.S. in Geophysics required. Send resumes to:

Department of Earth and Space Sciences
State University of New York
Stony Brook, New York 11794.

Ph.D.-Geochimist/Hydrogeologist. Research Planning Institute, Inc., a growing scientific consulting company, will hire a geochimist/hydrogeologist to work on terrestrial and marine pollution projects starting in May 1984. Necessary skills include: strong field experience as well as knowledge of organic and metallic pollutants. Experience in pollutant transport modeling highly desirable. Good communication skills imperative. Send resume and examples of previous work, published papers, and so forth, to:

Jacqueline Michel, Ph.D.
Research Planning Institute, Inc.
2950 Cypress Street
Columbia, SC 29201

